Combined Models of Thermophysical Properties of HFC 236ea on the Coexistence Curve Including the Critical Point

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Experimental data on properties, F = (the densities, ρ_l, ρ_g, the refractive indices, n_l, n_g, the saturation pressure, P_S), of HFC236ea along the coexistence curve (CC) are analysed in the work The input data sets are placed in the temperature interval from 240 K (close to the triple point temperature) up to T_c = 412.45 K and include results on ρ_l, ρ_g, (Aoyama H., Sato H., 1996, Defibaugh D., Moldover M., 1996, Stankus S., 2003), P_S (Zhang H., Sato H., 1995, Defibaugh D., Moldover M., 1996, Di Nicola, 2000) and , n_l, n_g (Schmidt J., Moldover M., 1996). The aim of the investigation is to obtain an analytical form of F that has the following structure with scaling and regular parts

$$F = F_{scale}(t,D,B1) + F_{reg}(t,B2), \qquad (1)$$

here $D = (\alpha,\beta,\delta,T_c,P_c,\rho_c)$: critical characteristics, $t = 1 - T/T_c$: a relative distance of T from the critical temperature T_c , B = (B1,B2) : amplitudes.

The degree laws of the scaling theory (ST) are taken into account to express $F_{scale}(t,D,B)$. Adjustable coefficients of the model (1) have to be determined by fitting F to experimental data, (F_{exp},t). In comparison with traditional methods, we have used not a single criterion, S2, but several criterions, S1,S2,Sc. S1 represents a RMS deviation of measured (F_{exp},t) - values from $F_{scale}(t,D,B)$ in the critical region, $0<t<0.1$. S2 represents a RMS deviation of measured (F_{exp},t) - data from the combined model F (1). A compromise criterion is chosen as $Sc^2 = (S1^2 + S2^2)$.

A routine is elaborated to calculate B coefficients of combined models (1). It has the following steps: i) to take D_0 from literature sources; ii) to form the criterion, $Sc(B, D_0)$, for the input data set; iii) to calculate values of B_0 using a least-squares analysis and a condition $Sc(B_0, D_0)$ = min, iv) to get a realization $F = f(D_0, B_0,t)$ and to estimate an approximation quality S1,S2 and $Sc(D_0 , B_0)$.

Our tests have shown that it is possible to find a better realization F = f (B1,D1,t) under the following conditions: i) we shift D with a small proper step, d_1, and get $D_1 = D_0 + d_1$ (for example, $Tc_1 = Tc_0 + d_1$), ii) we use the first routine and the condition, $Sc(B_1,D_1)$ = min, iii) we get a new realization $F = f(D_1, (B_1,t)$ with $Sc((B_1, D_1) < Sc(D_0 , B_0)$. The second routine [1] was elaborated for many steps treaty of the input data set to find an optimal realization, $F_{opt} = f(D_{opt},B_{opt},t)$ that follows to a condition: $S\tilde{n}(D_{opt},C_{opt})$ – Scmin < ε

Combined Models of F = (ρ_l, ρ_g, n_l, n_g, Ps) are built for R236ea. Calculated results correlate with measured data (Zhang H., Sato H., 1995, Defibaugh D., Moldover M., 1996, Aoyama H., Sato H., 1996, Schmidt J., Moldover M., 1996) in acceptable limits of an experimental accuracy. Fscale coincides in acceptable limits with experimental data placed in the interval $0 < t < 0.1$. Characteristics $D_{opt} = (\alpha\beta)_{opt}$ are placed not far from theoretical values recommended by ST. The models are compared with known equations; those are elaborated by Zhang H., Sato H., 1995, Defibaugh D., Moldover M., 1996, Aoyama H., Sato H., 1996, Schmidt J., Moldover M., 1996.

[1] E. Ustjuzhanin, J. Magee, J. Yata, B. Reutov, B. Grigoriev, K. Jakovenko, *Scaling models for thermodynamic properties of HFC 134a and HFC 143a on the Coexistence Curve.* In Proceedings of the 15th Symposium on Thermophysical Properties, June 22–27, 2003, Boulder, USA.